Additional Informatin WRT ECCV Permit Applicantion and EPA Data Request
Scott Mefford
to:
Wendy Cheung, pwob
03/30/2010 06:34 PM
Cc:
kscott
Show Details

History: This message has been replied to.
Wendy.. I just read through your note to Pat regarding your meeting with Denver and Aurora and noted your questions about faulting. Specifically concerning the faulting, the general thought is that the 5 major wrench faults identified along the front range are, in some manner, basement related. The proposed ECCV well lies on a block between two of these faults, the Lafayette Wrench Fault Zone, and the Cherry Creek Wrench Fault Zone, but does not directly overlie one of these high angle faults. These faults are outlined on the diagram below: (http://rmmcweb.cr.usgs.gov/frontrange/energy/petroleum_resources/faults.jpg), (Full paper: http://rmmcweb.cr.usgs.gov/frontrange/energy/petroleum_resources/Petroleum_resources_body.htm) (I may have not included this Higley paper in the References I sent earlier today as it is somewhat redundant with other references, however, we did review this and it should be included)

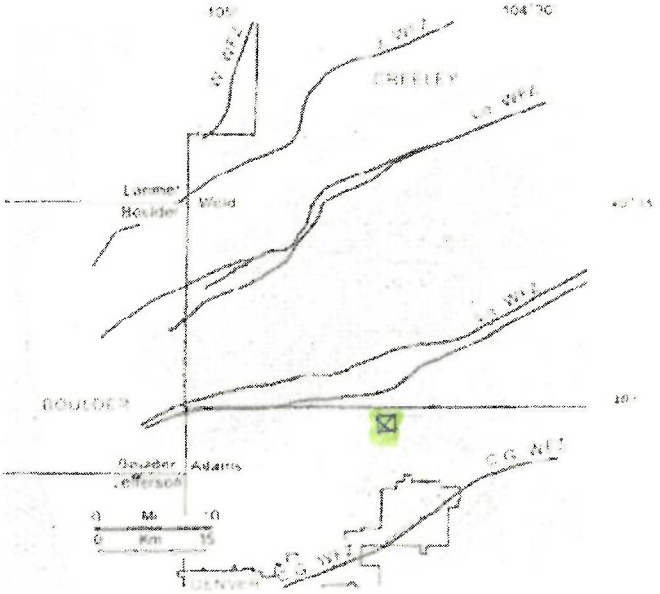
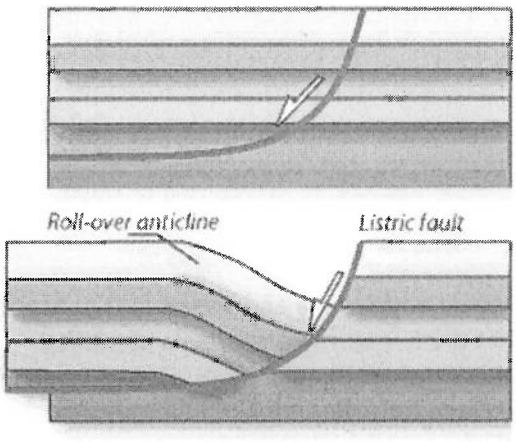


Figure 1. Distribution of gas wells (dots) in the Wattenberg field area, Denver Basin, Colorado. Wrench fault zones (WFZ) (Weimer, 1996) are thick lines. Fault zones are Windsor (W, WFZ), Johnstown (J, WFZ), Longmont (Lo, WFZ), Lafayette (La, WFZ), and Cherry Creek (CC, WFZ). Greatest gas production is concentrated between the Longmont WFZ and the Lafayette WFZ. Thin brown lines denote faults along the Front Range uplift (V pattern) and hypothetical faults of Weimer (1996) in the field area.

Between the major wrench faults, numerous minor faults are identified or hypothesized to exist. Undoubtedly there are some lesser faults in this region though their exact location is frequently difficult to define. Some of these lesser faults may be high angle wrench faults, but many are listric faults, or tensional faults whose angle of dip decreases with

depth. This is the nature of many of the faults in the Terry Sandstone referenced in your e-mail. These faults die out with depth as the angle of the fault decreases as depicted in the diagram below:



Clearly, faulting is evident in the Denver Basin, though we have no evidence of faulting specifically at the ECCV site. However, examining figure 1 above, we see many hundreds of oil and gas wells in the Greater Wattenberg Area. I believe you also have the map of the wells involved in injection in this area . Despite the large amount of fluids (petroleum fluids, water, and natural gas) being pumped into and out of this area, we don't see a seismic history associated with these activities in this basin. Seismicity at the arsenal was apparently associated with injection sequences in their deep well, but in that instance fluids were being injected directly into fractures and fault systems in the underlying Precambrian bedrock. This is not the case with the current injection wells operating in the basin, or the proposed ECCV well.

Hopefully that helps explain a little more about the faulting.

Scott Mefford

ECCV Disposal Well
Scott Mefford
to:
Wendy Cheung
04/08/2010 09:29 PM
Cc:
kscott
Show Details

Wendy: There has recently been considerable testimony presented to the State Engineer by the petroleum industry in regard to the tributary and/or non-tributary nature of produced waters from oil and gas wells. Although this is basically a water rights concern and had nothing to do with our program, there was a lot of testimony regarding the structure in the Denver Basin presented. Much of Dr. Weimers work was summarized in the exhibits presented, as well as the work of others. I am forwarding the exhibits from that testimony as much of it is drawn from Weimers work and includes copies of his key maps from his book. Other geologic sections are from RMAG studies, and other authors. (Note that a few pages in these exhibits have no relation whatsoever to what we are doing here, but as they were part of the original presentation, I have not been able tonight to split up the PDF's and remove them.)

As I indicated in the prior mail, and as I believe the Higley mapping I sent you demonstrates, there are 5 major wrench faults which penetrate the Greater Wattenberg Well Field area between Denver and Greeley. Weimers work corroborates this basic structural format for the basin as his maps also indicate. Maps of these wrench faults, including mapping of projected or hypothesized lesser faults (described by Weimer as antithetic and synthetic faults) which lie between the major wrench faults, are included for a variety of well fields in the area, including the Spindle Field, the Terry Sandstone (where much of the faulting is listric in nature) , the Boulder Weld County field, and the Greater Wattenberg Field. As we have discussed, and as the Higgley mapping shows, there are a great number of lesser faults projected throughout the Greater Wattenberg Area. Some of these are high angle normal faults, and some are listric faults. The ECCV well does not penetrate any of the 5 large wrench faults, and we have no geophysical or other data indicating faulting exists specifically at our site. However, there clearly are a host of minor antithetic and synthetic faults in the region, and throughout the Greater Wattenberg Area. The fact that these lesser faults exist, or are projected to exist, doesn't necessarily mean they are likely to create a seismic response if fluids are injected in the region. The Suckla Farms well lies in the in the region of lesser antithetic and synthetic faults between the major wrench systems, as does the proposed ECCV well. The Conquest wells lie near lesser faults throughout the basin and one of the Conquest wells in T1N R67W lies nearly on top of the major Lafayette Wrench Fault. Despite the proximity of these injection wells to the faults, we have not experienced increased seismicity. None of the injection wells feeding water into the sedimentary materials has resulted in seismic activity. The only seismic episodes noted in the region are related to the Arsenal injection into the Pre-Cambrian bedrock. Also, none of the faults noted, to my knowledge, have any history of movement during the Quaternary.

I have 2 additional basin cross sections I wanted to send, but cannot seem to get them shrunk down to the point they will e-mail, so I'm sending what I can. The missing cross sections are from other studies, not Weimer's work. I believe all the key Weimer maps are provided and will e-mail OK.

This may be more about the geology and faulting than you want to know, but maybe it will be helpful in understanding the basin. Also, I'm sure if you don't have a geology background some of the terminology is new. Following are definitions for the various faults Weimer discusses in his mapping. The definitions are not great, but maybe they will be of some assistance in understanding this. I am going to send you the materials in 4 sequential e-mails, each less than 7 MB so they will e-mail. Let me know if any of these get lost in the either or if you have questions..

Thanks

Scott

antithetic fault
A minor, secondary fault, usually one of a set, whose sense of displacement is opposite to its associated major and synthetic faults. Antithetic-synthetic fault sets are typical in areas of normal faulting.

synthetic fault
A type of minor fault whose sense of displacement is similar to its associated major fault. Antithetic-synthetic fault sets are typical in areas of normal faulting.

Listric fault
A curved downward-flattening fault, generally concave upward. Listric faults may be characterized by normal or reverse separation

Wrench Fault
A type of strike-slip fault in which the fault surface is vertical, and the fault blocks move sideways past each other

Normal Fault

A type of fault in which the hanging wall moves down relative to the footwall, and the fault surface dips steeply, commonly from 50° to 90°.